

### **III. Remarks**

Applicants have considered the Office Action with mailing date of June 26, 2006. Claims 1 – 20 are pending in this application. By this amendment, claims 1 and 9 have been amended. Applicants do not acquiesce in the correctness of the rejections and reserve the right to present specific arguments regarding any rejected claims not specifically addressed. Further, Applicants reserve the right to pursue the full scope of the subject matter of the original claims in a subsequent patent application that claims priority to the instant application. Reconsideration in view of the following remarks is respectfully requested.

Applicants note that the Office has made reference, on page 2 paragraph 4 – page 3 paragraph 1 of the current Office Action, to "Kim et al '307" which is not listed on the Notice of References Cited. Applicants believe that the Office has meant "Koh et al '307" as a short reference to US Publication No. 2004/0009307 instead of "Kim et al 307" and has prepared the current response on this basis. Applicant would appreciate the Office's clarification of this discrepancy.

In the Office Action, claims 1-20 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Kim et. al. (US Pub. No. 2005/0095443), hereinafter "Kim 443", in view of either Koh et. al. (US Pub. No. 2004/0009307), hereinafter "Koh 307", and Kim et. al. (US Pub. No. 2005/0101132), hereinafter "Kim 132". Applicants respectfully traverse the Office's rejections on the following grounds.

The Office has based the current rejection on the rationale that a person of ordinary skill in the art would apply the recited amounts of nitrogen in the re-iterative formation steps of the claimed invention based on Kim 443 and Koh 307. Applicants respectfully assert that the combined Kim 443-Koh 307 teachings do not teach or

suggest each and every feature of the claimed invention. For example, with respect to independent claims 1 and 9, Kim 443 and Koh 307 do not teach or suggest, *inter alia*, “forming a protective layer on a low-k material substrate [formed] by plasma-enhanced atomic layer deposition (PE-ALD) from a tantalum-based precursor and a nitrogen only plasma...”. As noted by the Office on page 2 of the current Office Action, Kim 443 does not disclose the formation of tantalum nitride using nitrogen only plasma but instead discloses using a mixture of nitrogen and hydrogen. Kim 443 discloses a method of using a mixture of hydrogen and nitrogen plasma for growing a thin tantalum nitride/tantalum diffusion barrier layer where the supply of nitrogen is reducible to substantially zero. Kim 443, ¶ [0007]. In the same vein, Koh 307 does not disclose the use of nitrogen only with tantalum precursors for forming a tantalum nitride layer on a low-k substrate. Koh 307 discloses a method using nitrogen gas in a mixture with hydrogen gas for forming tantalum nitride diffusion barrier layers through repeating deposition steps. Koh 307, ¶ [0018]. Applicants submit that Kim 443 and Koh 307 do not disclose or suggest nitrogen only in the plasma in forming the tantalum nitride layer of the protective layer. Without such a disclosure or suggestion, a person of ordinary skill in the art reading Kim 443 and Koh 307, independently or in combination, would not find the claimed method recited in claim 1 obvious. Accordingly, Applicants respectfully request that the Office withdraw the rejection of claims 1 and 9.

With further regard to independent claim 9, Applicants respectfully assert that Kim 443 and Koh 307 do not teach or suggest, *inter alia*, “...forming a protective layer on the low-k material substrate by conducting a first number of first cycles...” in addition to “... forming a subsequent substantially stoichiometric tantalum-nitride diffusion barrier layer by conducting a second number of second cycles...”. The Office cites ¶ [0011] in

Kim 443 and ¶ [0071] in Koh 307 to support this rejection. ¶ [0011] in Kim 443 teaches "...exposing substrate to tantalum halide ...; exposing substrate to hydrogen and nitrogen plasma; and repeating these steps ..." where "...the substrate may be simultaneously or sequentially exposed to the nitrogen plasma and the hydrogen plasma". ¶ [0071] in Koh 307 teaches "...supplying ...TaCl<sub>5</sub> (0.2 sec) → (N<sub>2</sub> + H<sub>2</sub>) (1.2 sec) ...repeated to form ...TaN layer". However, both cited paragraphs in Kim 443 and Koh 307 do not teach or suggest, in each first cycle, the method steps of "...exposing the substrate to a tantalum-based precursor, evacuating the chamber, plasma-enhanced atomic layer depositing (PE-ALD) from the tantalum-based precursor and a nitrogen plasma, and evacuating the chamber...". Claim 9. Where the cyclical implementation of exposing of the substrate to the respective reactive elements is conducted differently from the claimed invention, the result following the Kim 443-Koh 307 teachings would not lead to any likelihood of successfully forming the protective layer of the claimed invention. Accordingly, Applicants respectfully request that the Office withdraw the rejection of claim 9.

With respect to independent claim 17, Applicants respectfully assert that Kim 443 and Koh 307 do not teach or suggest, *inter alia*, "...the protective layer ... [has] a nitrogen content greater than a tantalum content". In contrast to the claimed invention, the teachings in Kim 443 [0008] and Koh 307 [0071] disclose a nitrogen:tantalum ratio that tends towards zero (i.e., Kim 443 and Koh 307 tend towards reducing the amount of nitrogen as opposed to the claimed invention). There would be no motivation for a person of ordinary skill to look to the teachings in Kim 443 and Koh 307 since the values as disclosed teaches against the claimed invention. Accordingly, Applicants respectfully request that the Office withdraw the rejection on claim 17.

The Office considers Kim 132 pertinent to the claimed invention by citing ¶ [0069], which discloses the use of nitrogen radicals. Applicants, however, are confused as to its applicability to the rejection because it is cited in the rejection but is later referred to as "not relied upon". Office Action, page 3. Clarification is requested. Applicants note, however, that similar to Kim 443 and Koh 307, Kim 132 teaches the formation of a diffusion barrier layer but does not teach or suggest "forming a protective layer on a low-k material substrate ... from a tantalum-based precursor and a nitrogen only plasma...". Claim 1. Specifically, Kim 132 teaches the formation of a diffusion barrier layer with grain boundaries, ¶ [0011], where the metal nitride layer is formed in the presence of nitrogen radicals and not nitrogen only.

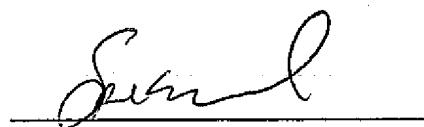
In view of the preceding paragraphs, Applicants respectfully submit that the Office has not provided factual support in establishing a prima facie case of obviousness under 35 USC §103(a). Therefore, Applicants assert that claims 1, 9 and 17 are non-obvious and patentable over Kim 443, Koh 307 and Kim 132. Applicants respectfully request that the Office withdraw the current rejections and allow all the claims of the present application.

Further to the above arguments, Applicants submit that each of the dependent claims is non-obvious for depending from non-obvious independent claims 1, 9 or 17. Furthermore, the dependent claims are patentable for one or more unique features. Applicants do not acquiesce to the Office's interpretation of the claimed subject matter or the references used in rejecting the claimed subject matter. Applicants reserve the right to present such arguments in a later response should one be necessary. Consequently, Applicants request that the Office withdraw the rejection and allow the dependent claims.

## VI. CONCLUSION

In light of the above, Applicants respectfully submits that all claims are in condition for allowance. Should the Examiner require anything further to place the application in better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the number listed below.

Respectfully submitted,



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Spencer K. Warnick,  
Reg. No. 40398

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Hoffman, Warnick & D'Alessandro LLC  
75 State Street  
14<sup>th</sup> Floor  
Albany, NY 12207  
Telephone: (518) 449-0044  
Fax: (518) 449-0047

SKW/TC